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ABSTRACT

The premise is advanced that a major weakness of the everyday generic instructional systems design model stems from a too modest traditional conception of the purpose and potential of formative evaluation. In the typical ISD (instructional systems design) model formative evaluation is shown not at all or as a single, product evaluation step. Yet in practice, formative process evaluation is also widely accepted as desirable and is more pervasive than the models would indicate because it is done informally. A broader theory of product-plus-process formative evaluation for instructional design is offered. The critical factors of this descriptive theory focus upon the desirability and viability of introducing formative evaluation techniques at the very beginning of the ISD process rather than at the end. A revised purpose of formative evaluation is theorized which envisions an ISD system that provides process feedback as well as product feedback, thus enabling the system to become truly self correcting. In the theoretical structure posited, the output of any observable or definable step in the ISD process is a deliverable. Furthermore, the case is stated that not only are all of these deliverables things that can be evaluated, but also that a system of evaluation which calls for all deliverables to be evaluated is parsimonious of effort in the long run and serves as a systemic quality control program. The term introduced here to mean evaluating all project deliverables as they are completed, is front-to-back formative evaluation. To illustrate the applicability of the proposed concept as a prescriptive theory, a graphic linear ISD model is presented which is an elaboration of the widely used Dick & Carey Model. The expanded model, called the Braden Formative Evaluation Model, clearly depicts the relationship between formation evaluation activities and instructional design and development procedures. Predictive evaluation is defined and distinguished from formative evaluation, with the suggestion that its role in instructional design needs to be fully elaborated. (26 references) (Author/BBM)

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The premise is advanced that a major weakness of the everyday generic instructional systems design model stems from a too modest traditional conception of the purpose and potential of formative evaluation. In the typical ISD model formative evaluation is shown not at all or as a single, **product** evaluation step. Yet, in practice formative **process** evaluation is also widely accepted as desirable and is more pervasive than the models would indicate because it is done informally. A broader theory of product-plus-process formative evaluation for instructional design is offered. The critical factors of this descriptive theory focus upon the desirability and viability of introducing formative evaluation techniques at the very beginning of the ISD process rather than at the end. A revised purpose of formative evaluation is theorized which envisions an ISD system that provides process feedback as well as product feedback, thus enabling the system to become truly self correcting. In the theoretical structure posited, the output of any observable or definable step in the ISD process is a deliverable. Furthermore, the case is stated that not only are all of these deliverables things that can be evaluated, but also that a system of evaluation which calls for all deliverables to be evaluated is parsimonious of effort in the long run and serves as a systemic quality control program. The term introduced here to mean evaluating all project deliverables as they are completed, is front-to-back formative evaluation. To illustrate the applicability of the proposed concept as a prescriptive theory, a graphic linear ISD model is presented which is an elaboration of the widely used Dick & Carey Model. The expanded model, called the Braden Formative Evaluation Model, clearly depicts the relationship between formative evaluation activities and instructional design and development procedures. Predictive evaluation is defined and distinguished from formative evaluation, with the suggestion that its role in instructional design needs to be fully elaborated.

Formative Evaluation: A Revised Descriptive Theory and a Prescriptive Model

The Trend Toward Formative Process Evaluation

In the past decade or so, but particularly in the past five years, this author and several others have moved away from a simple prescription for end-of-project formative product evaluation and toward more complex prescriptions for expanded formative evaluation as part of the ISD process (Braden 1987, 1991; Carey & Carey, 1980; Flagg, 1990; Nervig, 1990; Reeves, 1989; Van Patten, 1989). At the same time, however, there has been a continuation of highly respectable material written which has clung to the narrower conception of the role of formative evaluation in instructional design and development (e.g., Dick & Carey, 1990, 1991; Russsell & Blake, 1988).

A classic contribution to the unfolding of a broader definition of formative evaluation is Barbara Flagg's *Formative Evaluation for Educational Technologies* (1990). Although Flagg did not offer a model for process-oriented formative evaluation *per se*, she did identify four phases of formative evaluation. Taken together these phases represent a front-to-back implementation of formative evaluation methods. Flagg's phases were presented in the following format:

Phases of Program Development	Phases of Evaluation
Planning	Needs Assessment
Design	Pre-production Formative Evaluation
Production	Production Formative Evaluation
Implementation	Implementation Formative Evaluation

(Flagg, 1990, p. 35.)

The thought that all of us evaluate everything we do as we go along is so logical as to be considered fundamental. In that sense, suggesting that ID practitioners evaluate the output of each major step or activity as they proceed through instructional design and development could be interpreted as trivial, gratuitous, or even insulting. Therefore, the suggestion of this paper goes further, contending that casual consideration of the quality of work-in-progress is not the same thing as systematic, thorough, on-going formative evaluation. That said, the only thing new about front-to-back formative evaluation as a part of instructional design and development is a set of implementation ideas: (1) Steps should be added to ISD models to assure that formative evaluation is both systematic and systemic, and (2) The concept of **formal** front-to-back formative evaluation must be moved from the concept stage into everyday practice.

Models

A model for the evaluation of instructional development must, necessarily, be based upon the instructional systems design (ISD) process itself. Instructional systems design models are not in short supply. Twenty years ago Stamas (1972) wrote an occasional paper for the Division of Instructional Development that compared 23 ISD models. More recently, Gustafson (1991) considered 33 models before selecting a dozen to review in the second edition of a *Survey of Instructional Development Models*. In between times there have been literally dozens of models proposed. In a single article Andrews and Goodson (1980) analyzed 40 instructional design models selected from over 60 they had identified. Even with all of this outpouring of models—some descriptive, some prescriptive, some astute, some inane—only a few have gained more than passing attention because most of the models tend to be similar to each other.

Gropper (1977) compiled a list of 10 generally agreed upon steps found in most ISD models. Andrews and Goodson extended that list to 14 items, but conceded that all four additions were actually components of a single process, needs assessment. Thus a generally agreed upon list with 11 steps would include tasks associated with needs assessment, specifying outcomes, goal/task analysis, sequencing goals/objectives, identifying learner attributes, formulation of strategies, media selection, materials development, tryout/revision, and install/maintain. Notice that the term evaluation does not appear. In actuality, many of the models upon wh[illegible] the consensus steps were based included the term evaluation rather than tryout. This author holds that the step "install/maintain" is a post-design event and therefore isn't really an ISD step—which would leave us with 10 design steps as building blocks if we were inclined to create an all inclusive generic ISD model.

The conception of a systems process composed of a series of steps, whether they are those listed above or others, lends itself to a flow chart display. The principle model-design elements for flow charting are the box and the arrow. As a result, most ISD models are schematically some sort of elaboration upon the basic arrow-box-arrow design of the basic input-process-output model (see Figure 1).

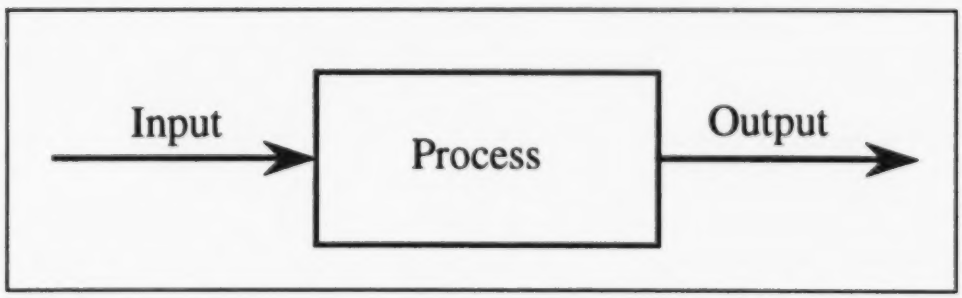

Figure 1. Basic Input-Process-Output Model

A common characteristic of even the earlier instructional systems models has been the feedback loop (e.g., Banathy, 1968). By applying a feedback loop to the basic input-process-output model we get something that looks like Figure 2.

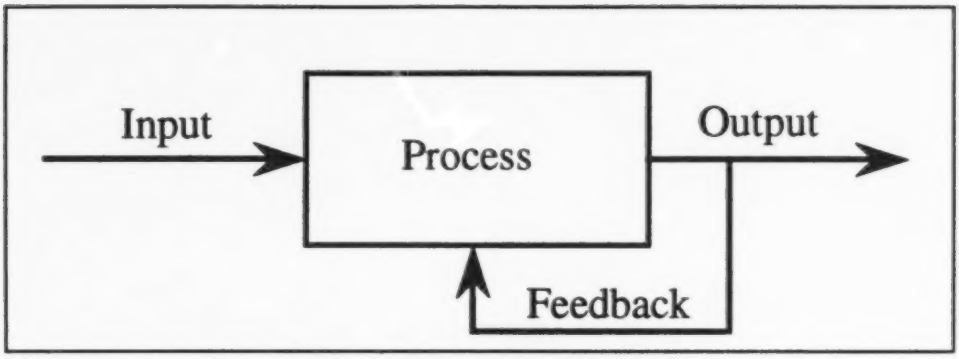

Figure 2. Basic Feedback Model

Next, if we consider that the source of any useful data to be fed back in the feedback loop is likely to be some form of evaluation of the output, we could construct a more accurate depiction of the basic feedback model. For example we might designate a circle with the letters F.E. inside to represent formative evaluation of the process output. The graphical result would look something like Figure 3.

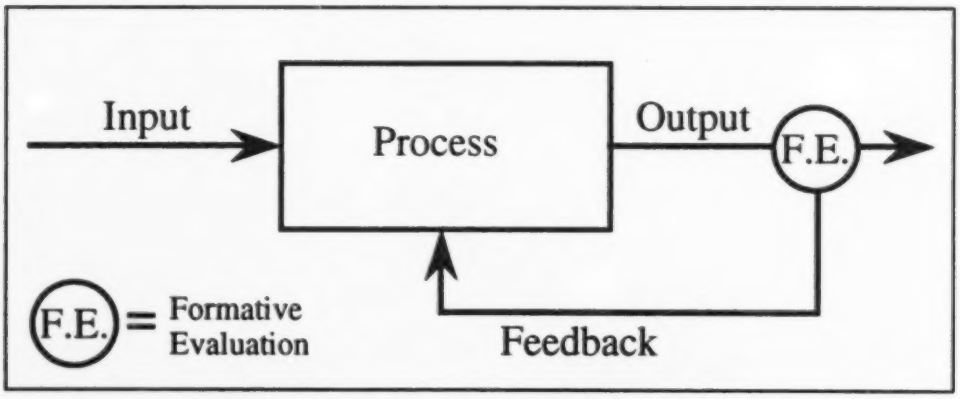

Figure 3. Basic Evaluation Feedback Model

Skipping ahead to a more complex graphic display of a procedure, we might wish to show several separate steps—as, for example, in a generic instructional systems model. We must bear in mind, however, that every box in a flowchart model represents its own sub-process. Thus, if we chose to do so we could display each traditional ISD macro-step as its own multiple step box-and-arrow model, showing all of the mini-steps. Complete with feedback loop, the diagrammatic features would be similar to Figure 4. Note that the input arrow is implied rather than shown and that output has been renamed "implement."

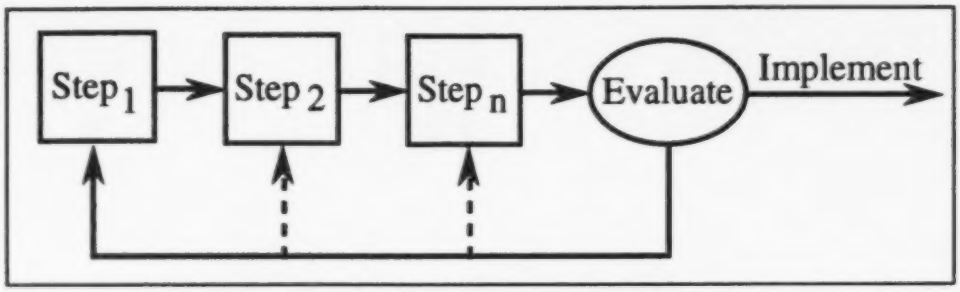

Figure 4. Diagram of a Multi-Step Generic ISD Model

Figure 5 illustrates what happens to our diagram when we consider that the ntire instructional design procedure is nothing more than a process which could be represented in a single box. We have a clear example of a self correcting process wherein the element of evaluation for feedback is the critical part of the process which dictates any needed revision.

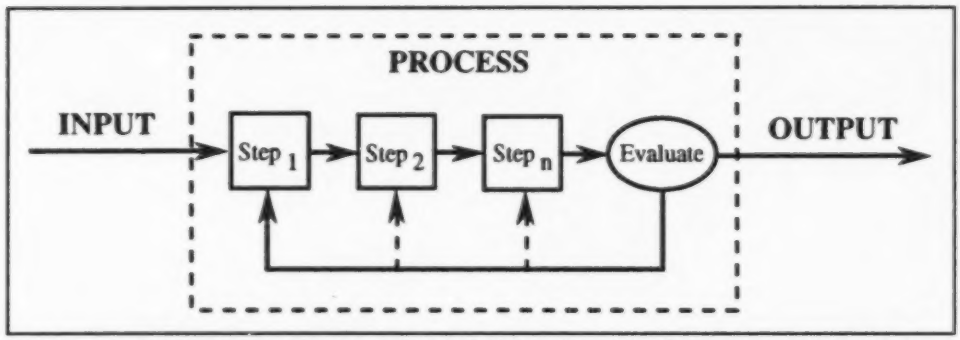

Figure 5. Input-Process-Output Model Combined with Generic ISD Model

An ISD Model That Is Also a Formative Evaluation Model

Front-to-Back Formative Evaluation

A major purpose of this paper is to propose an ISD model that is also an evaluation model. In simple terms, the key to the model is that each step results in one or more deliverables and that each deliverable is formatively evaluated and revised as necessary before proceeding to the next step. This concept of front-to back formative evaluation has been used successfully by the author in practice and in his classroom for several years (Braden, 1987). The ISD model which was proposed by Van Patten (1989) also calls for front-to-back formative evaluation, and is also based upon the premise that each deliverable should be specified, created, then formatively evaluated. Earlier, Carey & Carey (1980) suggested a general set of formative evaluation questions the answers to which would assist local selection committees in reviewing instructional materials. The Carey & Carey approach was comprehensive, dealing with all aspects of the instructional design process, but they did not suggest that each sub-process (step) be formatively evaluated before proceeding to the next step.

A Symbol for Formative Evaluation of Deliverables

A definition of the symbolic notation used by this author in a front-to-back formative evaluation model is critical to a full understanding of that model and its implications. Specifically, it is essential that readers know the meaning of a symbol made up of a rectangle with an embedded circle containing the letters F.E. In short, it means "formative evaluation is the last sub-step performed in that step of the model." Thus a box with an embedded F.E circle, although symbolically different, is identical in meaning to the box—arrow—F.E.Circle—feedback-loop diagram shown in Figure 3. *In essence the new symbol represents any process or procedure that has a built-in evaluation and revision provision,* ***making it self-correcting*** (see Figure 6).

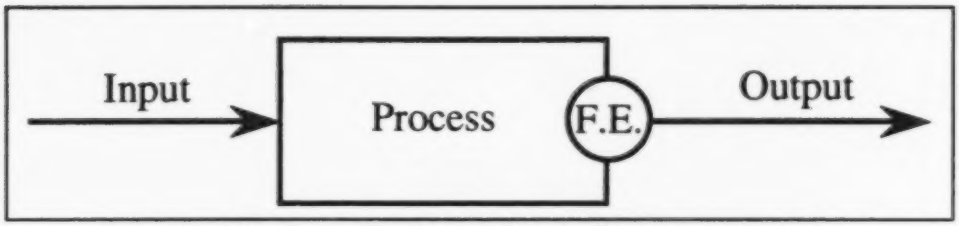

Figure 6. A New Icon: The Symbol for a Self-Correcting Procedure

The Elaborated Instructional Design Model

Revising the Structure of the Consensus ISD Model

Although the proliferation of instructional design models has slowed down from the frantic pace of the 1970's (Gustafson, 1991), between the "not invented here" syndrome and the insatiable need of certain personality types to tweak and polish, we can expect several new models each year. As Shrock has observed, during the 1970's, "experience with instructional development was revealing problems, and important and permanent modifications of the earlier models were made. One of the most important was the addition of needs assessment to the collection of steps that defined the process." (1991, p. 17.)

Three other important modifications could become generally accepted during the 1990's: elaboration of the step labeled "strategies" (Leshin, Pollock & Reigeluth, 1992), accommodation of the concurrent design of instruction and motivation (Keller, 1979, 1983), and integration of front-to-back formative evaluation (Braden, 1987; Van Patten, 1989). Adding motivation to the elaborated model and expanding the strategies component—while called for—are not the purposes of this paper. So those addenda will be left to another time.

Adding Front-to-Back Formative Evaluation Points to the ISD Model.

Elaborating the model with front-to-back formative evaluation is on the current agenda, and Figures 7a and 7b graphically illustrate how easily the modification can be made. To facilitate discussion, the elaborated model (Figure 7b.) has been labeled the Braden Model to distinguish it from its obvious predecessor, the Dick & Carey Model (Figure. 7.a.). The Dick & Carey Model is one of the three or four best known ISD models, and the text in which it is featured is now in a third edition (Dick &

Figure 7a. (left) The Dick & CArey Systems Approach Model for Designing Instruction. © 1990, Walter Dick and Lou Carey.

Figure 7b. (right) The Braden Formative Evaluation Model. © 1991

Carey, 1990). That particular model was selected for elaboration because of its recognition value. The original version of the elaborated Dick & Carey Model was first shown at the 1987 DID luncheon.

In its present form the Braden Model departs from the Dick & Carey Model in three significant ways. First, and most obvious, the "F.E." nodes have been added. Second, an "organize management" box has been added which includes writing the evaluation plan. Since management functions are apart from the design process, that box is displayed "off line." Third, the step which Dick and Carey label "Design and Conduct Formative Evaluation" has been more appropriately identified as "Conduct Prototype Test." That label was chosen in preference to "Tryout" because it was felt that "prototype" emphasized the formative nature of the instructional materials until after they "pass" the test.

- Formative Evaluation (F.E.) Nodes

A characteristic of each box in the Dick & Carey Model is that the box represents a discrete sub-process. An argument could be made that some or all of the sub-processes could be divided and displayed as two or more boxes each, but that is irrelevant. What matters is that the end of every sub-process shown is distinct, and is observable in the form of a tangible deliverable(s). Two factors were considered in adding these nodes: (1) Anything that is tangible can be evaluated. (2) In a linear process where linearity is a required condition, each step is a prerequisite for the one(s) that follow. In effect, the deliverable or output of step one is all or part of the input of step two.

The most radical aspect of the front-to-back formative evaluation procedure implied in the F.E. nodes is that there is a philosophical departure from the developmental testing of instruction (not the procedure for designing that instruction.) Walter Dick, the most frequently cited author on the subject of formative evaluation of instructional design, set a narrow focus for the field when he wrote, "These developmental testing procedures now tend to be considered as the operational definition of formative evaluation..." (Dick, 1980, p.3.) In terms of the types of evaluation defined by Stuffelbeam (1973), that operational definition limits formative evaluation to product evaluation. Inherent in the step-at-a-time evaluation scheme of the Braden Model is the opportunity to utilize evaluation data for the purpose of making appropriate alterations to the process. *[In fairness to Dick, he was absolutely correct. A limited concept of formative evaluation had been generally accepted. The tone was likely set by Bloom, Hastings and Madaus who authored a large format book of over 900 pages on formative and summative evaluation. Less than two pages of that tome were devoted to the prospect of using formative evaluation as the basis of altering the process and for the companion purpose of process quality control (see Bloom, Hastings, and Madaus, 1971, pp. 135-6.)]*

- Organize Management

  Project management has been a concern of instructional designers for two decades.One of the nine steps in the widely disseminated Instructional Development Institute (IDI) Model is "Organize Management" (N.M.S.I., 1971). In addition to logistics planning, time allocation, budgeting, and so forth, a critical management consideration is quality control. The heart of quality control is evaluation, and flaws caught early avoid compounding of errors which is desirable because simple errors are more easily remedied. Greer has recently brought new light to this often ignored aspect of instructional design. In a chapter about ID project management (Greer, 1991), he listed eight "inspection points" in the typical ID project. He followed that work with a textbook (Greer, 1992) on the same subject which included his version of an ISD model. In the Greer Model, phase I is "Project Planning," which coincides closely with the front-of-the-model location given to management planning in the Braden Formative Evaluation Model.

- Conduct Prototype Test

  Except for the change in terminology, there is no difference in what happens at this step in the Dick & Carey Model and in the Braden Model. Dick and Carey (1990, 1991) have done a splendid job of explaining the purposes and techniques of formative product evaluation as it applies to the instructional materials resulting from an instructional design project. Unquestionably their description of what is to occur at this step is a formative evaluation activity. However, the activity at that juncture is only a part of the total formative evaluation of the project, and therefore deserves a more accurate label: tryout or prototype test.

Imposing Front-to-Back Formative Evaluation upon Existing ISD Models

Not every ISD model can readily be adapted to incorporate front-to-back formative evaluation. However the majority or ISD models can be so adapted with ease. The requirements for applying the f-t-b formative evaluation component to an existing ISD model are:

1. The model should be linear. [Non-linear models might benefit also, but a major rationale for adding f-t-b F.E. would be lost.]

2. The model should be a prescriptive model for, not a descriptive model of.

   [*e.g.*, a graphic model for is the Dick & Carey Model (1990) which prescribes a sequence of design activities.]

[*e.g.*, a textual, non-graphic model of is Tennyson's Instructional Design Model (1990) which describes the linkage between cognitive learning theory and instructional prescriptions.]

[*e.g.*, a graphic model of is Tennyson's Model of Cognitive System for Educational Learning Theory (1992), which uses boxes and arrows, but uses them more to describe interactions than to prescribe linear function.]

How it Works

A fair question at this point would be, "OK, just what do you **do** in a front-to-back formative evaluation?" A short answer would be that at every F.E. node in the process you ask questions of consistency and adequacy. (For the origin of that method of assessing step-to-step quality, see Reigeluth's 1980 article on The Instructional Quality Profile.) In reality the full answer is much more complex. As with any evaluation effort, the exact methods depend upon the nature of the data we wish to collect. At the highest level of generalization, let us theorize how we might perform what is called for at an F.E. node. First, we would start with a deliverable (a product). Next we would ask questions of consistency such as: Is it appropriate? Does it reflect the input from the previous step? Is it consistent with the project goals, the performance objectives, etc.? We would then gather whatever data we deemed necessary to answer those questions to our satisfaction. Then, we would ask questions of adequacy such as: Is this sufficient? Will this deliverable be useable as the input for the next step in the ID process? Does this product reflect all of the elements of the input, *i.e.*, is it complete? Again we would choose the data gathering technique which best matched the circumstances and the nature of the information sought. With all of the data in hand we would assess the quality and ongoing utility of the deliverable. In the event that the evidence indicated that the deliverable was either inappropriate or insufficient, we would pose a different kind of question: What caused the flaw or inadequacy? The search for that answer invites process evaluation. We want to know what we did wrong, what we did poorly. If no process errors are detected, we would then loop back to the previous step to re-examine its output.

The Time Factor

Another fair question would be, "Isn't adding all of that routine checking of the deliverables too time consuming?" Again a short answer would be that if you never make mistakes, it is too time consuming. Otherwise, catching flaws and errors early tends to save time. Once you have prepared a set of checklists, routines, and questions to be used at each node, you will find that there is a high level of transfer of those tools to your next project. Armed with a set of evaluation instruments that need little or no revision, the task requires much less of your time.

Looking at the other addition that was made to the original Dick & Carey Model, a parallel question might be asked about the time consumed in the writing of an evaluation plan. The short answer to that is to be found in the management value

of the evaluation plan itself. Just knowing that everything will be put to the test establishes a mind set for high standards and excellence. Knowing that the building blocks of the present ID event have been sharply scrutinized adds confidence that the project is on track. Detection of problems that require remediation provides early warning that the time line for the project is in jeopardy, allowing the designer more time to renegotiate delivery dates or to bring more resources to bear on the project. The data gathering also has implications for matters of personnel management, budget monitoring, avoidance of political problems, and all kinds of other factors where information might be important to decision-making. Is the time spent worth all of these benefits? In most cases, yes. Besides, one evaluation plan tends to resemble all others. Just as there is a carryover of tools for the F.E. of deliverables, there is a carryover from evaluation plan to evaluation plan. After you have once assembled a plan that you like, large portions of it can be used as "boiler plate" in the writing of your next evaluation plan.

Being Consistent with Stuffelbeam's CIPP Model

The literature of evaluation is permeated with references to Stuffelbeam's CIPP Model (Stuffelbeam, 1973). Perhaps the most significant characteristic of CIPP is that it makes provision for holistic evaluation. Its elements are systems oriented, structured to accommodate universal evaluation needs. The tenets of CIPP are so widely accepted, so firmly rooted that they cannot be ignored. With that in mind, a reasonable course of action would be to use CIPP as a litmus test for any serious proposal of an evaluation system. Then, assuming that we consider the amount and nature of the evaluation encompassed within the instructional design process to constitute "an evaluation system," we can [should?] ask, "How does this system stack up in terms of CIPP?

- Context is evaluated in needs assessment when we evaluate the status quo. Flagg (1990) adopted the term needs assessment as the label for the first of her four phases of formative evaluation. In the model offered here, the evaluation of goals implies a consideration of whether it is appropriate to plan to employ instruction as the appropriate means to improve the status quo (the context).

- Input is evaluated in both needs assessment and during student analysis when we evaluate the students' entry competencies. Additionally, there is an element of input evaluation in what we do while assessing subject content during instructional goal/task analysis.

- Process evaluation is not prescribed in the vast majority of ISD models. Front-to-back F.E. as proposed herein does prescribe process evaluation. (Formative evaluation of the deliverable of any given ISD process step is product evaluation initially. However, as soon as a flaw in the product is determined, the procedure shifts to an evaluation of the process which permitted the flaw to occur.) **None of the ISD models reviewed in Gustafson (1991), Stamas (1970), Gropper (1977), or elsewhere include a step(s) for process evaluation.** Except for the model proposed here, only the Van Patten

Model, and the Flagg phases (both non-graphic) provide for process evaluation. Yet Reeves (1989, p. 164.) recognized that process evaluation was needed: "Obviously, prototype products will be a major focus of formative evaluation during an instructional design project, but there should be an equal emphasis on collecting formative evaluation to improve the overall instructional design **process**..." [Emphasis mine.]

- Product evaluation describes what happens in the ISD tryout step. Although referred to in the Dick & Carey and several other models as **formative evaluation**, and in many models simply as **evaluation**, the term **formative product evaluation** more accurately describes the tryout process. The term **prototype test**, as used in the model offered in this paper, is also a product evaluation label that accurately describes the procedure. As mentioned in the discussion of process evaluation, the F.E. nodes in the Braden Model are product evaluation points until a deficiency or product flaw is detected.

Predictive Evaluation

The terms formative and summative evaluation have been around long enough now that they are part of the vocabulary of every instructional designer and developer. In a black or white world those two forms of evaluation would represent the entire palette of evaluation choices. Things are not as simple as black and white, however, and even though our palette isn't a full spectrum rainbow, it does contain some tints and shades. Most notable, of course, is Needs Assessment which fits into neither the formative crate nor the summative barrel.

One way to view the kinds of evaluation that we need in ISD is to consider the underlying *purposes* of each.

- We use **discrepancy analysis evaluation** (including needs assessment) for establishing parameters during goal setting and some forms of decision making. Any decision that requires a choice will benefit from this kind of evaluation of the things that might be chosen.

- We use **formative evaluation** for quality control. Either the process or the associated products can be the focus of formative evaluation.

- We use **summative evaluation** for accountability purposes. Sometimes we perform summative evaluation just to satisfy our curiosity about how effective a product has been, but more likely needs for summative evaluation are linked to costs vs. benefits analysis and to decisions about program funding or survival. Summative evaluation is something that happens to instructional design, not something that is a part of it.

- And then there is that other kind of evaluation — the kind we use to improve our chances of being correct when we make a guess. For lack of a better term, let's call this kind of evaluation "**predictive evaluation**."

Instructional designers do a lot of predictive evaluating when they organize the management of projects. Budget estimation, time estimation, guesses about materials that will be used and the skills that will be required are all imprecise activities. Intuitively designers attempt to improve their guessing average by basing their estimates upon good, analyzed information. The art of forecasting will always contain a luck factor, but luck can be reduced by evaluating the options open to us. A method to assist us with the evaluative aspects of estimation would greatly benefit the instructional design and development field.

We are likely soon to find that predictive evaluation has become as much a part of ISD as formative evaluation —but in the form of an expert system rather than as a box in a model. If not, we will need to accommodate it in our evaluation models, if not in the ISD models themselves.

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